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(54) **INTERNAL COMBUSTION ENGINE AND  
STRADDLE-TYPE VEHICLE EQUIPPED  
WITH THE ENGINE**

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<b>F02B 77/11</b>	(2006.01)
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See application file for complete search history.

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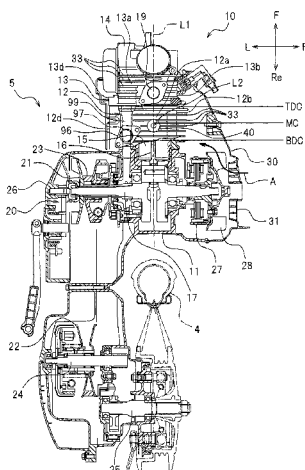
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**ABSTRACT**

In a single-cylinder internal combustion engine fitted with a knock sensor, a temperature increase of the knock sensor is suppressed and prevented, and the reliability of the knock sensor is improved. The engine includes a crankcase, a cylinder block connected to the crankcase, a cylinder head connected to the cylinder block, a sensor mounting boss provided on the cylinder block, and a knock sensor mounted to the boss. Fins are provided on the cylinder block and the cylinder head. A heat insulation member is provided between the boss and the knock sensor.

**11 Claims, 8 Drawing Sheets**



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FIG. 1

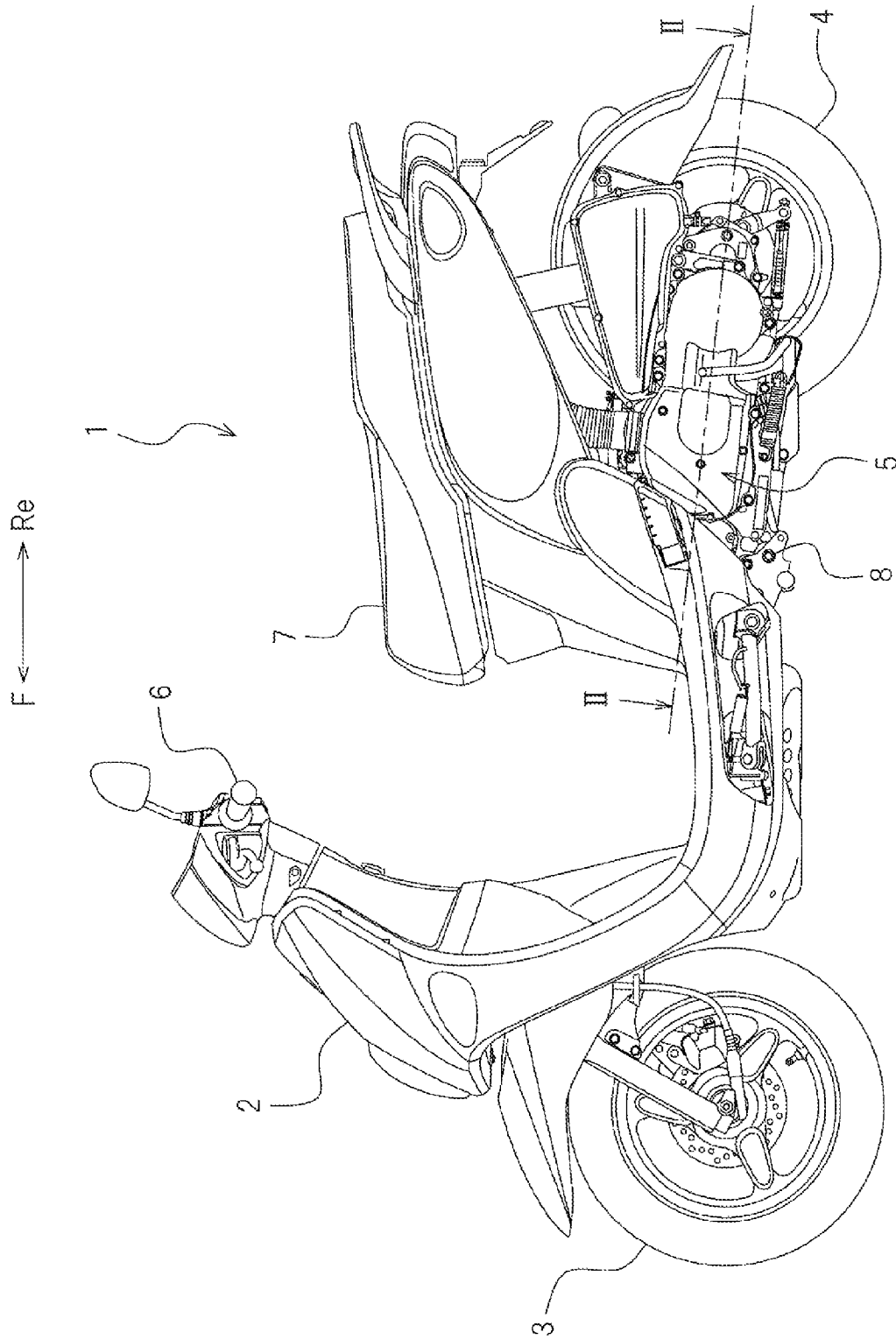


FIG. 2

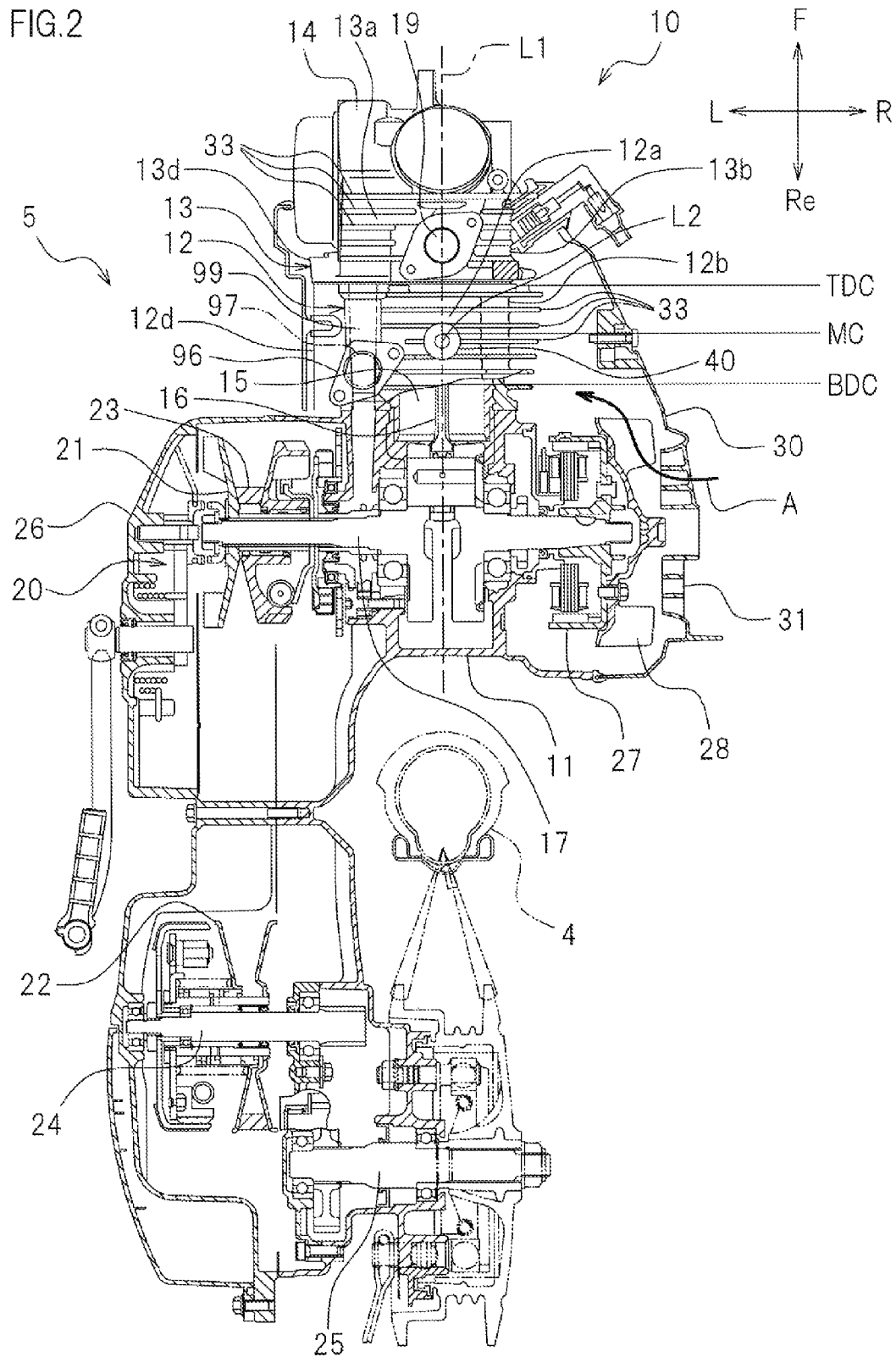


FIG. 3

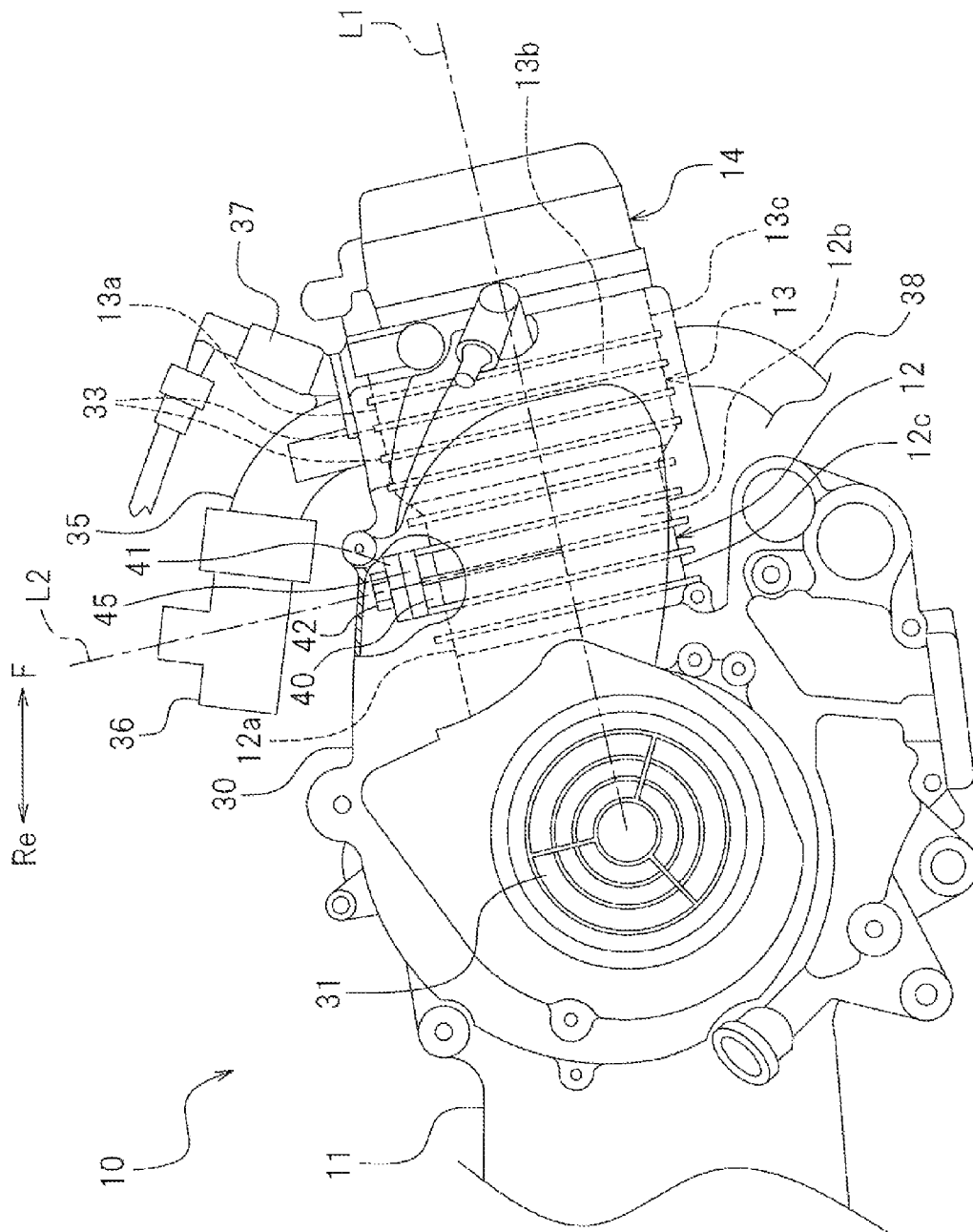


FIG. 4

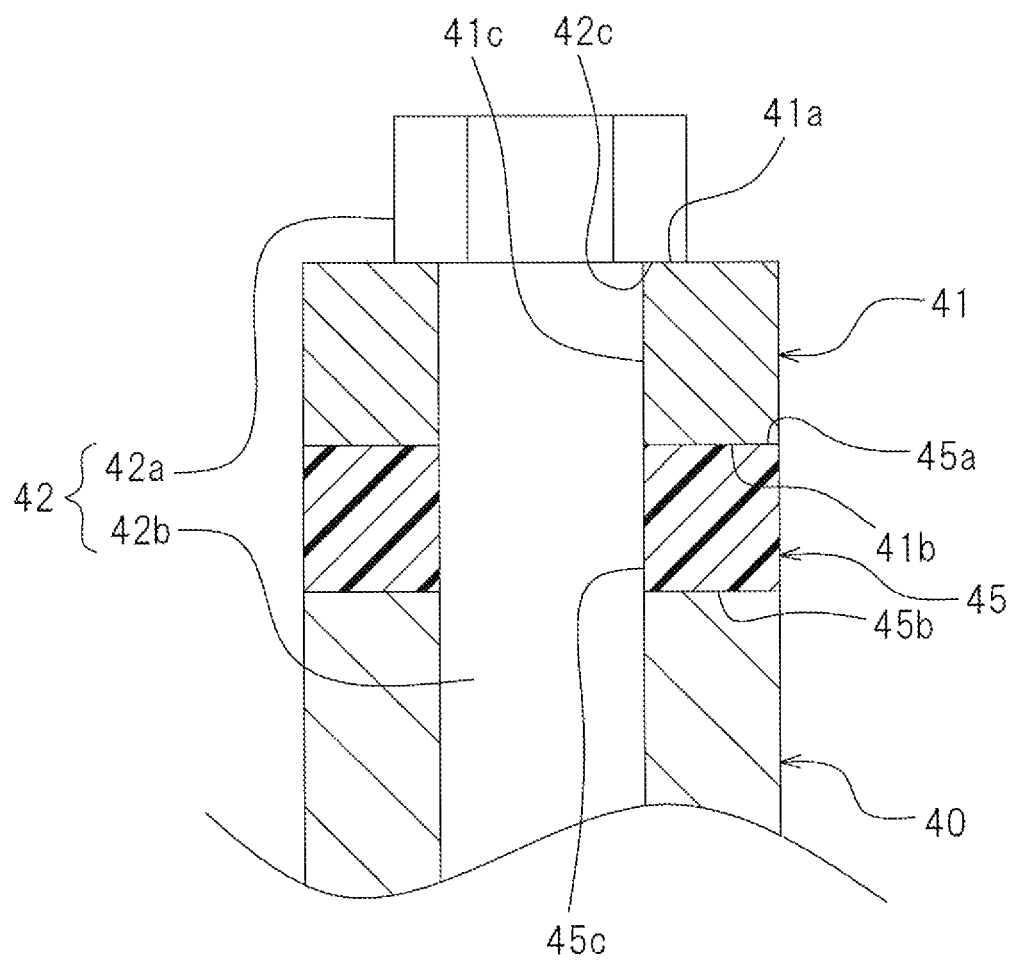


FIG. 5

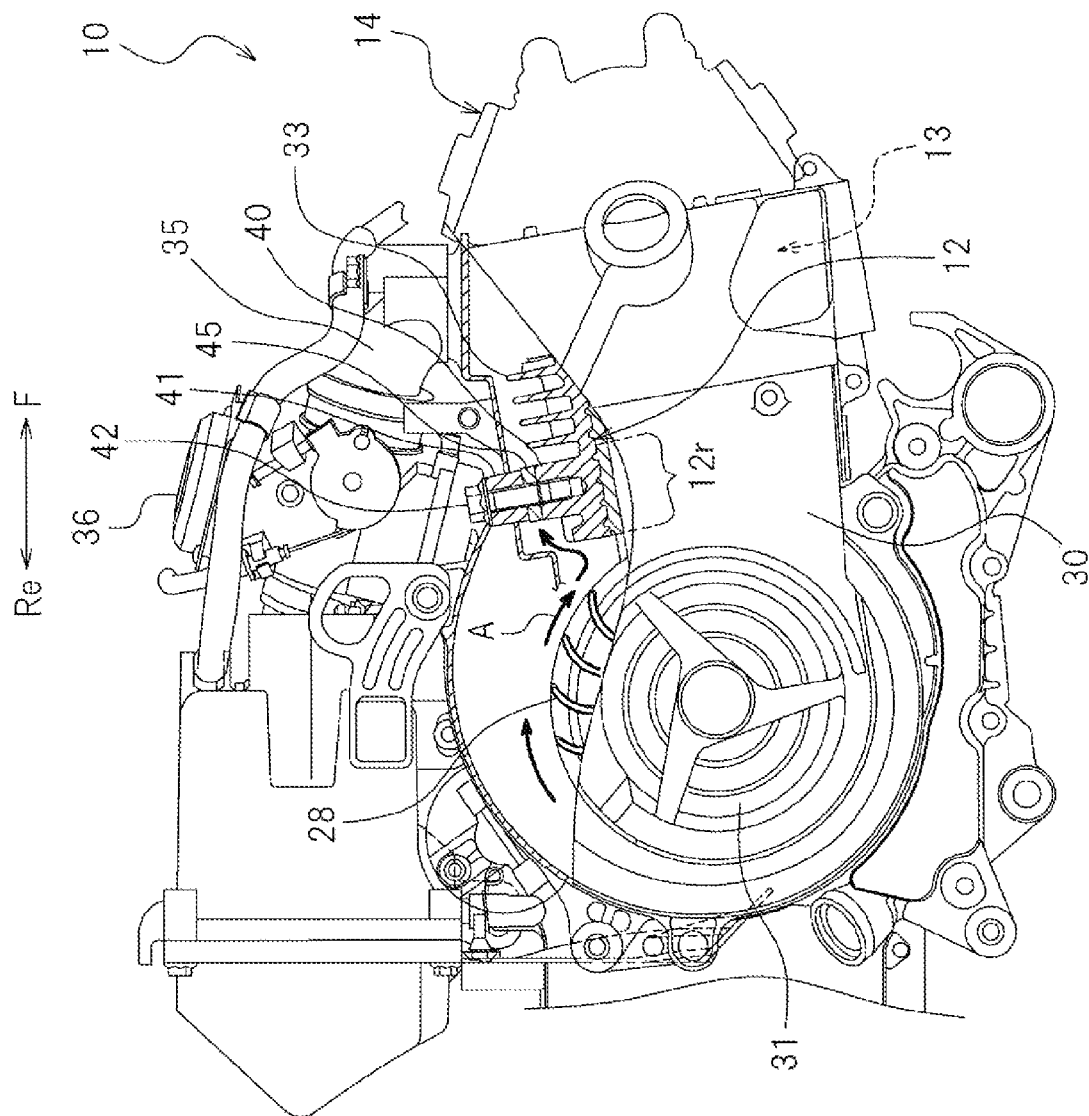


FIG. 6

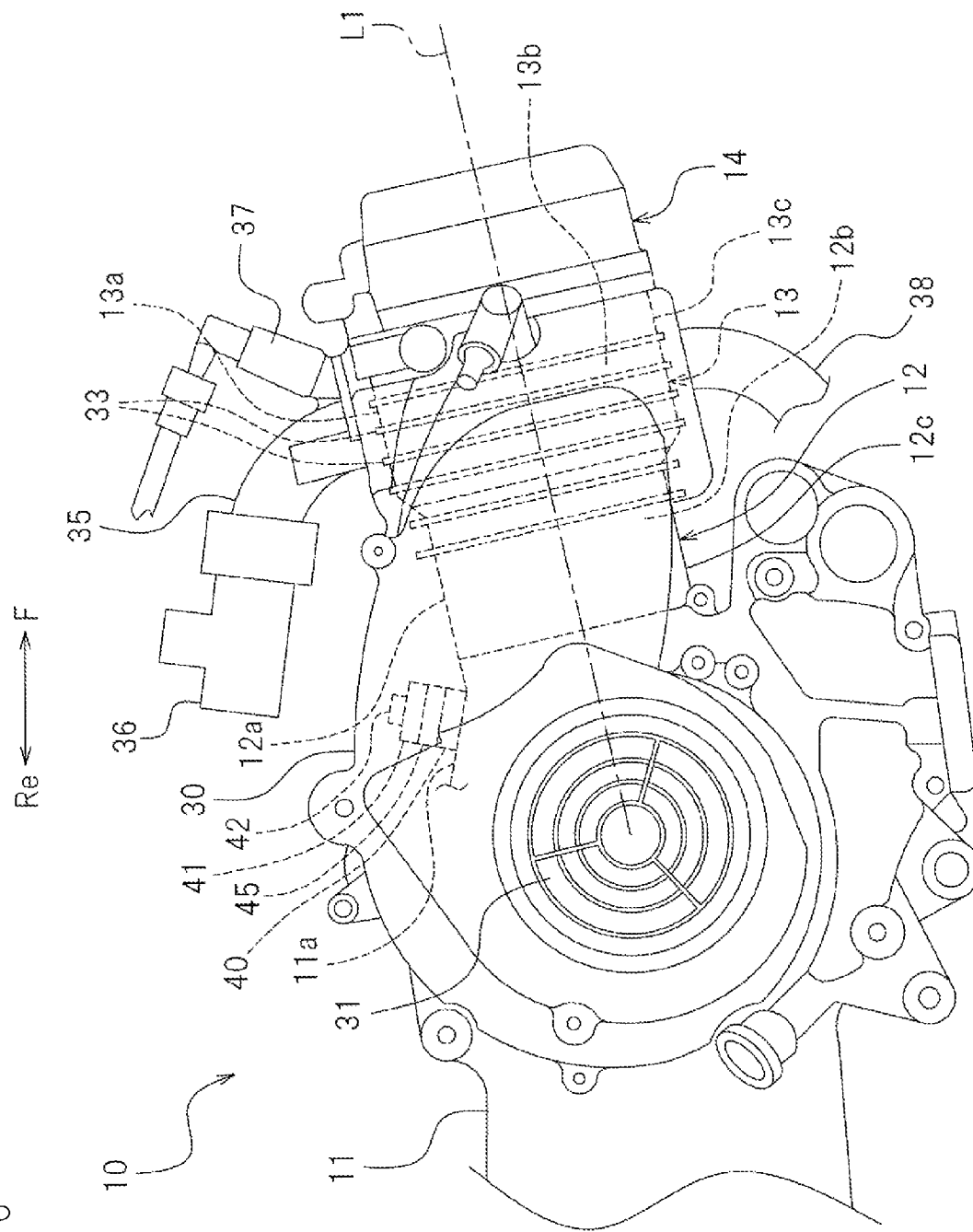
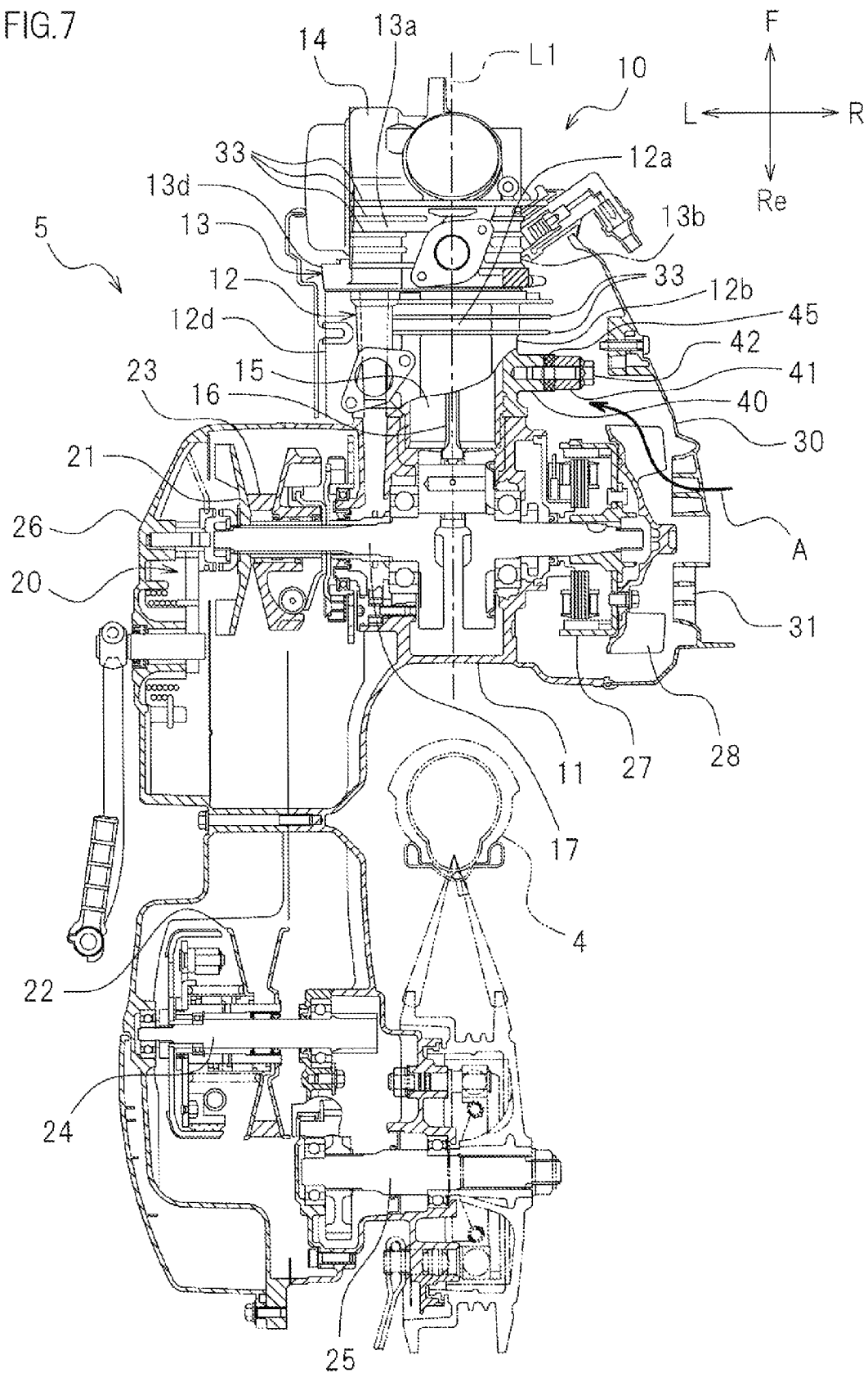
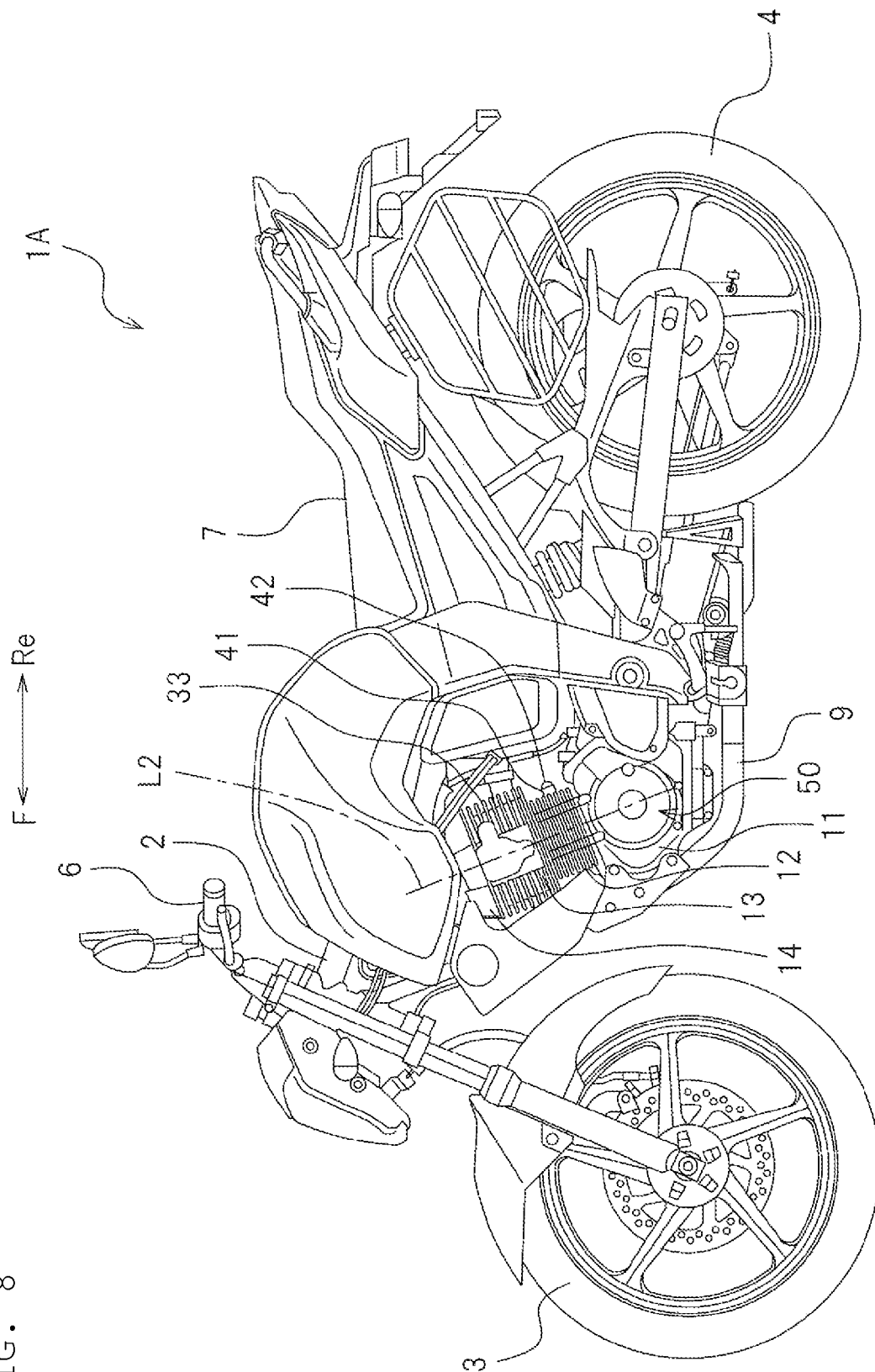


FIG. 7



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# INTERNAL COMBUSTION ENGINE AND STRADDLE-TYPE VEHICLE EQUIPPED WITH THE ENGINE

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to an internal combustion engine fitted with a sensor arranged to detect knocking. The present invention also relates to a straddle-type vehicle equipped with the engine.

### 2. Description of the Related Art

An internal combustion engine can cause knocking in some cases depending on its operating conditions. Knocking should be avoided as much as possible because it results in, for example, unusual noise and performance degradation of the internal combustion engine. Conventionally, it is known that a sensor to detect knocking, that is, a knock sensor, is fitted to an internal combustion engine. It is also known that, upon detecting knocking by the knock sensor, an action such as changing ignition timing is taken.

JP 2004-301106 A discloses a water-cooled engine in which a knock sensor is fitted to a cylinder block.

A water-cooled engine needs a flow passage for coolant, i.e., a water jacket, to be provided in, for example, a cylinder block and a cylinder head. It also requires, for example, a pump to convey the coolant and a radiator to cool the coolant. For this reason, the structure of the water-cooled engine tends to be complicated.

A straddle-type vehicle equipped with a single-cylinder internal combustion engine (hereinafter referred to as a "single-cylinder engine") is known, such as a relatively small-sized motorcycle. The single-cylinder engine has the advantage that it has a simpler structure than a multi-cylinder engine. To fully exploit this advantage, the single-cylinder engine has a relatively simple cooling structure. For that reason, conventionally, at least a portion of the cylinder block and the cylinder head is cooled by air.

In the air-cooled engine provided with fins, the cylinder block and so forth are cooled from the surface. On the contrary, in the water-cooled engine, the cylinder block and so forth are cooled from a water jacket disposed inside the surface. The knock sensor is disposed on a boss provided on the surface of the engine. This means that, when the boss is provided for the air-cooled engine including fins, engine cooling becomes insufficient, and consequently, cooling of the knock sensor may become insufficient. In other words, when the above-described conventional technique, in which it is assumed that cooling is done from the inside of the surface of the engine, is applied to the air-cooled engine, the temperature of the knock sensor may become too high, degrading the reliability of the knock sensor.

## SUMMARY OF THE INVENTION

In view of the problems described above, preferred embodiments of the present invention suppress and prevent the temperature increase of the knock sensor and improve the reliability of the knock sensor in a single-cylinder internal combustion engine fitted with a knock sensor.

A preferred embodiment of the present invention provides a single-cylinder internal combustion engine for a vehicle including: a crankcase accommodating a crankshaft; a cylinder block connected to the crankcase and including a cylinder provided therein; a cylinder head connected to the cylinder block; a sensor mounting boss provided on the crankcase, the cylinder block, or the cylinder head; a sensor

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arranged to detect knocking, the sensor being mounted to the boss; a fin provided on at least a portion of the cylinder block and the cylinder head; and a heat insulation member interposed between the boss and the sensor, wherein the heat insulation member is made of a material having a lower thermal conductivity than the boss.

Various preferred embodiments of the present invention make it possible to suppress and prevent the temperature increase of the knock sensor and to improve the reliability of the knock sensor in a single-cylinder internal combustion engine fitted with a knock sensor.

The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a left side view of a motorcycle according to a first preferred embodiment of the present invention.

FIG. 2 is a cross-sectional view taken along line II-II of FIG. 1.

FIG. 3 is a right side view illustrating a portion of an engine according to the first preferred embodiment of the present invention.

FIG. 4 is a cross-sectional view illustrating a boss, a heat insulation member, and a knock sensor through which a bolt is inserted.

FIG. 5 is a right side view illustrating a portion of an engine according to a second preferred embodiment of the present invention.

FIG. 6 is a right side view illustrating a portion of an engine according to a third preferred embodiment of the present invention.

FIG. 7 is a cross-sectional view corresponding to FIG. 2, illustrating an engine unit according to a fourth preferred embodiment of the present invention.

FIG. 8 is a left side view of a motorcycle according to a fifth preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

### First Preferred Embodiment

As illustrated in FIG. 1, the straddle-type vehicle according to the first preferred embodiment is preferably a scooter type motorcycle 1, for example. Although the motorcycle 1 is one example of the straddle-type vehicle according to a preferred embodiment of the present invention, the straddle-type vehicle is not limited to the scooter type motorcycle 1. The straddle-type vehicle may be any other type of motorcycle, such as a moped type motorcycle, an off-road type motorcycle, or an on-road type motorcycle, for example. In addition, the straddle-type vehicle is intended to mean any type of vehicle on which a rider straddles the vehicle, and it is not limited to a two-wheeled vehicle. The straddle-type vehicle may be, for example, a three-wheeled vehicle that changes its traveling direction by leaning the vehicle body. The straddle-type vehicle may be other types of straddle-type vehicle such as an ATV (All Terrain Vehicle), for example.

In the following description, the terms "front," "rear," "left," and "right" respectively refer to front, rear, left, and right based on the perspective of the rider of the motorcycle

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1. Reference characters F, Re, L, and R in the drawings indicate front, rear, left, and right, respectively.

The motorcycle 1 includes a vehicle body 2, a front wheel 3, a rear wheel 4, and an engine unit 5 to drive the rear wheel 4. The vehicle body 2 includes a handlebar 6, which is operated by the rider, and a seat 7, on which the rider is to be seated. The engine unit 5 is what is called a unit swing type engine unit, and it is supported by a body frame, not shown in the drawings, so that it can pivot about a pivot shaft 8. The engine unit is supported so as to be swingable relative to the body frame.

FIG. 2 is a cross-sectional view taken along line II-II of FIG. 1. As illustrated in FIG. 2, the engine unit 5 includes an engine 10, which is one example of the internal combustion engine according to a preferred embodiment of the present invention, and a V-belt type continuously variable transmission (hereinafter referred to as "CVT") 20. The CVT 20 is one example of a transmission. In the present preferred embodiment, the engine 10 and the CVT 20 integrally form the engine unit 5, but it is of course possible that the engine 10 and a transmission may be separated from each other.

The engine 10 is preferably an engine that includes a single cylinder, in other words, a single-cylinder engine. The engine 10 is preferably a four-stroke engine, which repeats an intake stroke, a compression stroke, a combustion stroke, and an exhaust stroke, one after another, for example. The engine 10 includes a crankcase 11, a cylinder block 12 extending frontward from the crankcase 11, a cylinder head 13 connected to a front portion of the cylinder block 12, and a cylinder head cover 14 connected to a front portion of the cylinder head 13. A cylinder 15 is provided inside the cylinder block 12.

The cylinder 15 may be defined by a cylinder liner inserted in the body of the cylinder block 12 (i.e., in the portion of the cylinder block 12 other than the cylinder 15) or may be integrated with the body of the cylinder block 12. In other words, the cylinder 15 may be provided either separate from or integral with the body of the cylinder block 12. A piston, not shown in the drawings, is slidably accommodated in the cylinder block 15.

The cylinder head 13 covers a front portion of the cylinder 15. A recessed portion, not shown in the drawings, and an intake port and an exhaust port, also not shown in the drawings, that are connected to the recessed portion are provided in the cylinder head 13. An intake pipe 35 (see FIG. 3) is connected to the intake port, and an exhaust pipe 38 is connected to the exhaust port. The top surface of the piston, the inner circumferential surface of the cylinder 15, and the recessed portion together define a combustion chamber, which is not shown in the drawings. The piston is coupled to a crankshaft 17 via a connecting rod 16. The crank shaft 17 extends leftward and rightward. The crank shaft 17 is accommodated in the crankcase 11.

In the present preferred embodiment, the crankcase 11, the cylinder block 12, the cylinder head 13, and the cylinder head cover 14 are preferably separate parts, and they are fitted to each other. However, they may not be separate parts but may be integrated with each other as appropriate. For example, the crankcase 11 and the cylinder block 12 may be integral with each other, or the cylinder block 12 and the cylinder head 13 may be integral with each other. Alternatively, the cylinder head 13 and the cylinder head cover 14 may be integral with each other.

The CVT 20 includes a first pulley 21, which is a driving pulley, a second pulley 22, which is a driven pulley, and a V-belt 23 wrapped around the first pulley 21 and the second pulley 22. A left end portion of the crankshaft 17 protrudes

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to the left from the crankcase 11. The first pulley 21 is fitted to the left end portion of the crankshaft 17. The second pulley 22 is fitted to a main shaft 24. The main shaft 24 is coupled to a rear wheel shaft 25 via a gear mechanism, which is not shown in the drawings. FIG. 2 depicts the state in which the transmission ratio for a front portion of the first pulley 21 and the transmission ratio for a rear portion of the first pulley 21 are different from each other. The second pulley 22 preferably has the same configuration. A transmission case 26 is provided on the left side of the crankcase 11. The CVT 20 is accommodated in the transmission case 26.

An alternator 27 is provided on a right side portion of the crankshaft 17. A fan 28 is secured to a right end portion of the crankshaft 17. The fan 28 rotates with the crankshaft 17. The fan 28 sucks air to the left by rotating. An air shroud 30 is disposed on the right side of the crankcase 11, the cylinder block 12, and the cylinder head 13. The alternator 27 and the fan 28 are accommodated in the air shroud 30. The air shroud 30 and the fan 28 are one example of an air guide member, and they serve the role of guiding air mainly to the crankcase 11, the cylinder block 12, and the cylinder head 13. A suction port 31 is provided in the air shroud 30. The suction port 31 is positioned on the right side of the fan 28. The suction port 31 is provided at a position facing the fan 28. As indicated by arrow A in FIG. 2, the air sucked by the fan 28 is introduced through the suction port 31 into the air shroud 30 and is supplied to, for example, the crankcase 11, the cylinder block 12, and the cylinder head 13.

FIG. 3 is a right side view illustrating a portion of the engine 10. As illustrated in FIG. 3, the air shroud 30 is mounted to the crankcase 11, the cylinder block 12, and the cylinder head 13, and it extends frontward along the cylinder block 12 and the cylinder head 13. The air shroud 30 covers right side portions of the crankcase 11, the cylinder block 12, and the cylinder head 13. In addition, the air shroud 30 partially covers upper and lower portions of the cylinder block 12 and the cylinder head 13.

As illustrated in FIG. 3, the engine 10 according to the present preferred embodiment is preferably a type of engine in which the cylinder block 12 and the cylinder head 13 extend in a horizontal direction or in a direction inclined slightly upward with respect to a horizontal direction toward the front, that is, what is called a horizontally mounted type engine. Reference character L1 represents a line that passes through the center of the cylinder 15 (see FIG. 2, the line is hereinafter referred to as the "cylinder axis"). The cylinder axis L1 extends in a horizontal direction or in a direction slightly inclined from a horizontal direction. It should be noted, however, that the direction of the cylinder axis L1 is not particularly limited. For example, the inclination angle of the cylinder axis L1 with respect to the horizontal plane may be from 0° to 15°, for example, or may be greater.

The engine 10 according to the present preferred embodiment is preferably an air-cooled engine, the entire body of which is cooled by air. As illustrated in FIG. 2, a plurality of cooling fins 33 are provided on the cylinder block 12 and the cylinder head 13. However, the engine 10 may be an engine that includes the cooling fins 33 and also a portion of which is cooled by coolant. In other words, the engine 10 may be an engine a portion of which is cooled by air but another portion of which is cooled by coolant.

Although the specific shape of the fins 33 is not particularly limited, the fins 33 of the engine 10 according to the present preferred embodiment have the following shape. The fins 33 according to the present preferred embodiment protrude from the surfaces of the cylinder block 12 and the

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cylinder head 13 and extend so as to be orthogonal or substantially orthogonal to the cylinder axis L1. In other words, the fins 33 extend in a direction orthogonal or substantially orthogonal to the surfaces of the cylinder block 12 and the cylinder head 13. The fins 33 are arrayed in a direction along the cylinder axis L1. Gaps are provided between adjacent fins 33. The gap between the fins 33 may be uniform or may not be uniform.

In the present preferred embodiment, the fins 33 that are provided on the cylinder block 12 are provided over the top surface 12a, the right surface 12b, and the bottom surface 12c (see FIG. 3) of the cylinder block 12. The fins 33 that are provided on the cylinder head 13 are provided over the top surface 13a, the right surface 13b, the bottom surface 13c (see FIG. 3), and the left surface 13d of the cylinder head 13. It should be noted, however, that the position of the fins 33 is not particularly limited. The fins 33 may be provided either only on the cylinder block 12 or only on the cylinder head 13.

The thicknesses of the plurality of fins 33 are preferably equal to each other. However, the fins 33 may have different thicknesses one from another. Each one of the fins 33 may have a uniform thickness irrespective of the location therein or may have different thicknesses from one location therein to another. In other words, the thickness of each of the fins 33 may be locally different.

In the present preferred embodiment, each of the fins 33 may have a flat plate shape so that the surface of the fin 33 is a flat surface. However, the fin 33 may be curved, and the surface of the fin 33 may be a curved surface. In addition, the shape of the fin 33 is not limited to a flat plate shape, and the fin 33 may have various other shapes such as needle shapes and hemispherical shapes. When the fin 33 has a flat plate shape, the fin 33 does not need to extend in a direction orthogonal or substantially orthogonal to the cylinder axis L1 but may extend in a direction parallel or substantially parallel to the cylinder axis L1. Alternatively, the fin 33 may extend in a direction inclined with respect to the cylinder axis L1. The plurality of the fins 33 may extend either in the same direction or in different directions from each other.

As illustrated in FIG. 2, a sensor mounting boss 40 is provided on the top surface 12a of the cylinder block 12. The boss 40 is disposed above the cylinder block 12. In other words, the boss 40 is disposed above the engine body (that is, the portion of the engine 10 excluding the boss 40). As viewed in plan, the boss 40 is disposed at a position that overlaps with the engine body. As will be described below, an intake pipe 35 is connected to the top surface of the cylinder head 13. The boss 40 is provided on a surface of the cylinder block 12 that corresponds to the surface of the cylinder head 13 to which the intake pipe 35 is connected. It is also possible to provide the boss 40 on the cylinder head 13. The boss 40 may be provided on the top surface of the cylinder head 13, or may be provided on the surface of the cylinder head 13 to which the intake pipe 35 is connected.

In FIG. 2, reference numeral 19 is an intake port. Although not shown in the drawings, the intake port extends obliquely downward and rearward, forming a curve. As illustrated in FIG. 2, the right end of the boss 40 is positioned more to the right than the left end of the intake port 19, and the left end of the boss 40 is positioned more to the left than the right end of the intake port 19. That is, at least a portion of the boss 40 and at least a portion of the intake port 19 are disposed at an aligned position with respect to the left-right direction. In other words, at least a portion of the boss 40 and at least a portion of the intake port 19 are aligned, one in front and the other behind. Here, when viewed from a

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direction orthogonal or substantially orthogonal to the cylinder axis L1, both the center of the boss 40 and the center of the intake port 19 are positioned on the cylinder axis L1. Thus, at least a portion of the boss 40 and at least a portion of the intake port 19 are at an aligned position with respect to the left-right direction so that a knock sensor 41 to be mounted to the boss 40 can be protected by the intake port 19 from a flying stone or the like from the front. In addition, the knock sensor 41 can be protected by the intake pipe 35 mounted to the intake port 19.

A chain case 99 is provided on a left side portion of the cylinder block 12. A cam chain is disposed inside the chain case 99. A mount portion 96 to mount a cam chain tensioner 97 is provided on a portion of the chain case 99, that is, on a left side portion of the top surface 12a of the cylinder block 12. The cam chain tensioner 97 is inserted into a hole of the mount portion 96 so as to come into contact with the cam chain. The rear end of the boss 40 is positioned more to the rear than the front end of the cam chain tensioner 97, and the front end of the boss 40 is positioned more to the front than the rear end of the cam chain tensioner 97. That is, at least a portion of the boss 40 and at least a portion of the cam chain tensioner 97 are disposed at an aligned position with respect to the front-rear direction. In other words, at least a portion of the boss 40 and at least a portion of the cam chain tensioner 97 are aligned, one on the right and the other on the left. Thus, the knock sensor 41 mounted to the boss 40 can be protected by the mount portion 96 and the cam chain tensioner 97.

The boss 40 is preferably integral with the cylinder block 12. The boss 40 preferably has a tubular shape having a large wall thickness. The top surface of the boss 40 preferably has a flat surface. It should be noted, however, that the shape of the boss 40 is not particularly limited as long as the later-described knock sensor 41 can be mounted thereto. In the present preferred embodiment, the boss 40 is continuous with some of the fins 33. In other words, the boss 40 is connected to some of the fins 33. More specifically, no gap is provided between the boss 40 and those fins 33. In the present preferred embodiment, the boss 40 and those fins 33 are integral with each other.

In the present preferred embodiment, the boss 40 is connected to three of the fins 33, for example. It should be noted, however, that the number of the fins 33 that are connected to the boss 40 is not limited to three. The boss 40 may be connected to either a plurality of the fins 33 or with only one of the fins 33.

In addition, although the boss 40 is connected to some of the fins 33 in the present preferred embodiment, the boss 40 may not be connected to the fins 33. The boss 40 may be provided at a portion of the cylinder block 12 or the cylinder head 13 where no the fins 33 are provided.

As illustrated in FIG. 2, the boss 40 is provided at a position overlapping the cylinder axis L1, as viewed in plan. The boss 40 is provided at a position such that an extension line L2 of the center of the boss 40 (see FIG. 3) intersects with the cylinder axis L1. The boss 40, however, may be provided at a position such that the extension line L2 of the center of the boss 40 does not intersect with the cylinder axis L1. For example, the boss 40 may be provided at a position that overlaps with an inner portion of the cylinder 15 but does not overlap with the cylinder axis L1, when viewed from a direction along the center of the boss 40. It is also possible to arrange the boss 40 at a position that does not overlap with an inner portion of the cylinder 15, when viewed from a direction along the center of the boss 40.

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The front-rear position of the boss **40** is not particularly limited. In the present preferred embodiment, the center **C2** of the boss **40** is positioned closer to the bottom dead center BDC than the midpoint MC between the top dead center TDC and the bottom dead center BDC of the piston. It is also possible to dispose the boss **40** further closer to the bottom dead center BDC. Conversely, it is also possible to dispose the boss **40** so as to be positioned closer to the top dead center TDC than the midpoint MC between the top dead center TDC and the bottom dead center BDC of the piston.

As illustrated in FIG. 3, the height of the boss **40** may be the same as the height of the fins **33**. Alternatively, the height of the boss **40** may be higher than the height of the fins **33**. In other words, a portion of the boss **40** may protrude above the fins **33**. Alternatively, the height of the boss **40** may be lower than the height of the fins **33**. The boss **40** extends in a direction orthogonal or substantially orthogonal to the top surface **12a** of the cylinder block **12**. Since the fins **33** protrude in a direction orthogonal or substantially orthogonal to the top surface **12a** of the cylinder block **12**, the protruding direction of the boss **40** and the protruding direction of the fins **33** are parallel or substantially parallel to each other. However, the protruding direction of the boss **40** is not particularly limited, and the boss **40** may protrude in a direction inclined with respect to the top surface **12a** of the cylinder block **12**.

As illustrated in FIG. 3, a heat insulation member **45** is placed on the boss **40**, and the knock sensor **41** arranged to detect knocking is mounted on the heat insulation member **45**. The heat insulation member **45** is a member having a lower thermal conductivity than the boss **40**. The heat insulation member **45** and the knock sensor **41** are preferably mounted to the boss **40** by a bolt **42**. When knocking occurs, the combustion pressure abruptly changes, so specific vibration occurs in, for example, the cylinder block **12** and the cylinder head **13**. As the knock sensor **41**, it may be preferable to use, for example, a sensor that detects vibration and converts the vibration into an electric signal to output the signal (for example, a sensor equipped with a piezoelectric element).

FIG. 4 is a schematic cross-sectional view illustrating the boss **40**, the heat insulation member **45**, the knock sensor **41**, and the bolt **42**. The heat insulation member **45** preferably has a cylindrical shape. The heat insulation member **45** preferably has a cylindrical shape having substantially the same inner diameter and substantially the same outer diameter as those of the boss **40**. However, the inner diameter of the heat insulation member **45** may be different from the inner diameter of the boss **40**, and the outer diameter of the heat insulation member **45** may be different from the outer diameter of the boss **40**. The heat insulation member **45** may not necessarily have a cylindrical shape. For example, the heat insulation member **45** may have a C-shaped cross section, for example. The heat insulation member **45** includes an obverse surface **45a** and a reverse surface **45b**. Both the obverse surface **45a** and the reverse surface **45b** are preferably flat surfaces. A through-hole **45c** passing from the obverse surface **45a** through to the reverse surface **45b** is provided at the center of the heat insulation member **45**. In the present preferred embodiment, the heat insulation member **45** preferably is a single member. It is also possible, however, that the heat insulation member **45** includes a plurality of members. For example, the heat insulation member **45** may be provided by laminating a plurality of annular members.

The knock sensor **41** preferably also has a cylindrical shape. The knock sensor **41** preferably has a cylindrical

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shape having substantially the same inner diameter and substantially the same outer diameter as those of the boss **40**. However, the shape of the knock sensor **41** is not limited to the cylindrical shape and may be other shapes. The inner diameter of the knock sensor **41** may be different from the inner diameter of the boss **40**, and the outer diameter of the knock sensor **41** may be different from the outer diameter of the boss **40**. The knock sensor **41** includes an obverse surface **41a** and a reverse surface **41b**. Both the obverse surface **41a** and the reverse surface **41b** are preferably flat surfaces. A through-hole **41c** passing from the obverse surface **41a** through to the reverse surface **41b** is provided at the center of the knock sensor **41**. In the present preferred embodiment, the inner diameter of the through-hole **41c** of the knock sensor **41**, the inner diameter of the through-hole **45c** of the heat insulation member **45**, and the inner diameter of the boss **40** are preferably equal to each other.

The bolt **42** is a fastener used to mount the heat insulation member **45** and the knock sensor **41** to the boss **40**. The bolt **42** includes a head **42a** and a shaft portion **42b** extending downward from the head **42a**. The head **42a** and the shaft portion **42b** are preferably integral with each other. The head **42a** has a larger diameter than the shaft portion **42b**. The head **42a** has a hexagonal cross section, for example, so that it can engage with a tool such as a hex wrench. It should be noted, however, that the shape of the head **42a** is not particularly limited. For example, a straight slot or a cross slot engaging with a screwdriver may be provided in the head **42a**. Alternatively, another type of engaging portion to engage with a tool to rotate the head **42a** may be provided in the head **42a**.

In the present preferred embodiment, although not shown in the drawings, a helical groove is provided in the outer circumferential surface of the shaft portion **42b**. A helical groove is also provided in the inner circumferential surface of the boss **40**. The heat insulation member **45** and the knock sensor **41** are placed on the boss **40** in that order, and after the bolt **42** is inserted from above into the through-hole **41c** of the knock sensor **41**, the through-hole **45c** of the heat insulation member **45**, and the boss **40**, the bolt **42** is tightened by a tool so that the bolt **42** can be fastened.

The obverse surface **41a** of the knock sensor **41** is in contact with the head **42a** of the bolt **42**. The reverse surface **41b** of the knock sensor **41** is in contact with the obverse surface **45a** of the heat insulation member **45**. By fastening the bolt **42** sufficiently, the obverse surface **41a** of the knock sensor **41** and the head **42a** of the bolt **42** are brought into direct contact with each other, and the reverse surface **41b** of the knock sensor **41** and the obverse surface **45a** of the heat insulation member **45** are brought into direct contact with each other. Bringing the reverse surface **41b** of the knock sensor **41** and the obverse surface **45a** of the heat insulation member **45** into direct contact with each other enables vibrations to be transmitted from the boss **40** via the heat insulation member **45** to the knock sensor **41**. Also, bringing the obverse surface **41a** of the knock sensor **41** and the head **42a** of the bolt **42** into direct contact with each other enables vibrations to be transmitted from the boss **40** to the knock sensor **41** through the bolt **42**.

It is also possible to provide a helical groove that engages with the helical groove of the bolt **42** in one or both of the inner circumferential surface of the through-hole **45c** of the heat insulation member **45** and the inner circumferential surface of the through-hole **41c** of the knock sensor **41**. When a helical groove is provided in the inner circumferential surface of the through-hole **41c** of the knock sensor **41**, the contact area between the bolt **42** and the knock sensor

41 is increased, so that vibration can be better transmitted from the bolt 42 to the knock sensor.

However, the method of securing the bolt 42 is not necessarily limited to the just-described method. Another possible method is as follows. A bolt 42 is embedded in the boss 40 in advance, then the heat insulation member 45, the knock sensor 41, and a nut are fitted to the bolt 42 in that order, and then, the nut is tightened.

The heat insulation member 45 reduces the amount of heat that is transmitted from the boss 40 to the knock sensor 41. The heat insulation member 45 is a material having a lower thermal conductivity than the material of the cylinder block 12 (i.e., the material of the boss 40). However, since the knock sensor 41 is a sensor that detects vibration, it is preferable that the heat insulation member 45 be made of a material that does not easily damp vibrations. It is preferable that the heat insulation member 45 be made of a material that suppresses heat conduction but does not easily damp vibrations. Generally, a material having a high density can transmit vibrations. The material of the heat insulation member 45 is not particularly limited, but, for example, it is possible to suitably use a material that has a thermal conductivity about  $1/10$  or less (preferably about  $1/100$  or less) and a density of about  $1/10$  or greater of that of the material of the cylinder block 12.

The heat insulation member 45 and the boss 40 may be made of the same kind of material or may be made of different kinds of materials. For example, the boss 40 may be made of a metal (such as cast iron and aluminum) while the heat insulation member 45 may be made of a resin. It is also possible that the boss 40 may be made of a metal while the heat insulation member 45 may be made of a ceramic.

The material of the cylinder block 12 is not particularly limited. Usable examples include ADC12 (DC material) having a thermal conductivity, as determined according to JIS R1611, of about 96 W/(m·K) and a density of about 2.68 kg/m<sup>3</sup>, AC4B (LP) having a thermal conductivity of about 134 W/(m·K) and a density of about 2.77 kg/m<sup>3</sup>, FC250 (cast iron) having a thermal conductivity of about 50 W/(m·K) and a density of about 7.3 kg/m<sup>3</sup>, and alumina ceramic having a thermal conductivity of about 29 W/(m·K) and a density of about 3.9 kg/m<sup>3</sup>. A suitable example of the heat insulation member 45 is a phenolic resin. The thermal conductivity of the phenolic resin determined according to JIS A1412 is about 0.2 W/(m·K), which is less than  $1/100$  of the thermal conductivities of the above-mentioned materials. In addition, the density of the phenolic resin is about 1.25 kg/m<sup>3</sup>, which is greater than  $1/10$  of the densities of the above-mentioned materials.

As illustrated in FIG. 3, the intake pipe 35 is connected to the top surface 13a of the cylinder head 13. A throttle body 36 that accommodates a throttle valve, which is not shown in the drawings, is connected to the intake pipe 35. When viewed from the side, the knock sensor 41 is disposed below the intake pipe 35 or the throttle body 36. A fuel injection valve 37 is disposed in front of the intake pipe 35. When viewed from the side, the knock sensor 41 is disposed on the opposite side of the intake pipe 35 (the left side of FIG. 3) to the side on which the fuel injection valve 37 is disposed (the right side of FIG. 3). The exhaust pipe 38 is connected to the bottom surface 13c of the cylinder head 13.

The heat generated by combustion in the combustion chamber is conducted mainly from the cylinder block 12 via the boss 40 to the knock sensor 41. That is, the knock sensor 41 is heated mainly by heat conduction from the boss 40. However, in the engine 10 according to the present preferred embodiment, the heat insulation member 45 is provided

between the boss 40 and the knock sensor 41. This serves to prevent the knock sensor 41 from being heated by the boss 40. As a result, the temperature increase of the knock sensor 41 can be inhibited because the knock sensor 41 is not easily heated by the boss 40, so the reliability of the knock sensor 41 can be enhanced.

When the heat insulation member 45 is interposed between the boss 40 and the knock sensor 41, the vibration transmitted from the boss 40 to the knock sensor 41 may be damped, and the detection accuracy of the knock sensor 41 may be lowered. Nevertheless, in the present preferred embodiment, a portion of the bolt 42 that mounts the knock sensor 41 is in contact with the boss 40, and another portion thereof is in contact with the knock sensor 41. More specifically, the head 42a of the bolt 42 is in contact with the obverse surface 41a of the knock sensor 41, and a portion of the outer circumferential surface of the shaft portion 42b of the bolt 42 is in contact with the inner circumferential surface of the boss 40. This means that the vibration of the boss 40 is transmitted to the knock sensor 41 not just through the heat insulation member 45 but also through the bolt 42. The bolt 42 serves the role of transmitting the vibration of the boss 40 to the knock sensor 41, in addition to the role of fitting the knock sensor 41 and the heat insulation member 45 to the boss 40. Therefore, even though the heat insulation member 45 is interposed between the boss 40 and the knock sensor 41, the detection accuracy of the knock sensor 41 can be kept high.

The combustion chamber is provided inside the cylinder block 12 and the cylinder head 13. When knocking occurs in the combustion chamber, vibration resulting from the knocking propagates from the combustion chamber to the cylinder block 12, the cylinder head 13, and so forth. In the present preferred embodiment, the knock sensor 41 is mounted to the cylinder block 12. The knock sensor 41 is disposed in the vicinity of the combustion chamber, in other words, in the vicinity of the location at which knocking occurs. As a result, it is possible to detect knocking with high accuracy by the knock sensor 41.

Although the vicinity of the combustion chamber is a location suitable to detect knocking, it is a location in which the temperature is high. The temperature of the cylinder block 12 tends to be higher than that of the crankcase 11. Consequently, merely mounting the knock sensor 41 on the boss 40 of the cylinder block 12 may pose a risk of heating the knock sensor 41 by the cylinder block 12 with a high temperature, causing the temperature of the knock sensor 41 to become too high. However, according to the present preferred embodiment, the heat insulation member 45 is provided between the boss 40 and the knock sensor 41 as described above. Therefore, although the knock sensor 41 is mounted to the cylinder block 12, the temperature increase of the knock sensor 41 can be suppressed and prevented.

The cylinder head 13 includes the top surface 13a, the right surface 13b, the bottom surface 13c, and the left surface 13d. The intake pipe 35 is connected to the top surface 13a, while the exhaust pipe 38 is connected to the bottom surface 13c. The cylinder block 12 likewise includes the top surface 12a, the right surface 12b, the bottom surface 12c, and the left surface 12d. The boss 40 is provided on the top surface 12a. More specifically, the boss 40 is provided on, of the surfaces 12a to 12d of the cylinder block 12, the surface 12a that corresponds to the surface 13a of the cylinder head 13 to which the intake pipe 35 is connected. Air at ambient temperature flows through the intake pipe 35, while high-temperature exhaust gas after combustion flows through the exhaust pipe 38. Accordingly, the intake pipe 35

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is cooler than the exhaust pipe 38, and the top surface 12a and the top surface 13a are cooler than the bottom surface 12c and the bottom surface 13c. According to the present preferred embodiment, the boss 40 is provided on the top surface 12a, which is cooler than the bottom surface 12c. Therefore, the temperature increase of the knock sensor 41 can be even more suppressed and prevented.

The fins 33 are provided on the cylinder block 12 and the cylinder head 13. As a result, the cooling capability of the cylinder block 12 and the cylinder head 13 can be enhanced. In addition, in the engine 10 according to the present preferred embodiment, the boss 40 is connected to some of the fins 33. As a result, the heat of the boss 40 does not remain in the boss 40 itself, but it is released vigorously through the fins 33. The cooling capability of the boss 40 is enhanced, and the temperature of the boss 40 is prevented from becoming excessively high. Therefore, it becomes possible to suppress and prevent the temperature increase of the knock sensor 41 further.

With the engine 10 according to the present preferred embodiment, airflow is guided to the boss 40 by the air shroud 30. As a result, the boss 40 can be cooled effectively by the air. This means that the cooling capability of the boss 40 is high, preventing the temperature of the boss 40 from becoming excessively high. Thus, the temperature increase of the knock sensor 41 can be suppressed and prevented further.

Moreover, the air guided by the air shroud 30 is supplied to the knock sensor 41, in addition to the boss 40. Accordingly, the knock sensor 41 itself can also be cooled effectively by the air. In addition, the air shroud 30 covers at least a portion of the cylinder block 12 and the cylinder head 13. The air shroud 30 supplies air not only to the boss 40 but also to the cylinder block 12, the cylinder head 13, and so forth. As a result, the cylinder block 12, the cylinder head 13, and so forth can be cooled effectively. This also serves to prevent the temperature increase of the boss 40 and suppress and prevent the temperature increase of the knock sensor 41.

As illustrated in FIG. 3, the intake pipe 35 and the throttle body 36 are disposed above the boss 40. As a consequence, if the air shroud 30 is not provided, there may be cases in which the air flow stagnates in the region around the boss 40 that is above the top surface 12a of the cylinder block 12, due to the influence of the intake pipe 35 and the throttle body 36. Nevertheless, in the present preferred embodiment, a sufficient flow of air can be supplied to the boss 40, which is positioned below the intake pipe 35 or the throttle body 36, because the air shroud 30 is provided. As a result, the boss 40 can be cooled effectively, and the temperature increase of the knock sensor 41 can be suppressed and prevented.

As the motorcycle 1 runs, an airflow from the front to the rear is produced. In the present preferred embodiment, the cylinder block 12 and the cylinder head 13 extend frontward and obliquely upward from the crankcase 11. As illustrated in FIG. 3, the cylinder axis L1 is inclined from a horizontal plane. For that reason, without any design change, air does not flow smoothly over the top surface 12a of the cylinder block 12 in comparison with the right surface 12b, the bottom surface 12c, and the left surface 12d. However, according to the present preferred embodiment, air can be supplied to the boss 40 by the air shroud 30. As a result, although the boss 40 is provided on the top surface 12a, to which air is inherently not supplied smoothly, the boss 40 can be cooled sufficiently, and the temperature increase of the knock sensor 41 can be suppressed and prevented.

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As the motorcycle 1 runs, air flows from the front to the rear. It is also possible to cool the boss 40 and so forth by the airflow that occurs in association with running of the motorcycle 1, without using the fan 28. However, such an air flow does not occur when the motorcycle 1 temporarily stops, that is, when idling. According to the present preferred embodiment, as long as the crankshaft 17 is rotating, air can be supplied by the fan 28. Even when idling, air can be supplied to the boss 40 and so forth, so the temperature increase of the knock sensor 41 can be suppressed and prevented more effectively.

In the present preferred embodiment, the boss 40 is provided on the cylinder block 12. However, it is also possible to provide the boss 40 on the cylinder head 13. In this case, the boss 40 is disposed at a location even closer to the location at which knocking occurs, so the detection accuracy of the knock sensor 41 can be even more increased. On the other hand, the cylinder head 13 tends to become hotter than the cylinder block 12. However, in this case as well, the temperature increase of the knock sensor 41 can be suppressed and prevented by interposing the heat insulation member 45 between the boss 40 and the knock sensor 41.

While the motorcycle 1 is running, there are cases in which stone chips, dirt, and the like are kicked up from the ground. If such kicked-up stone chips and the like collide against the knock sensor 41, the condition of mounting of the knock sensor 41 may worsen and the detection accuracy may degrade. In addition, the knock sensor 41 may fail. However, according to the present preferred embodiment, the boss 40 is provided on the top surface 12a of the cylinder block 12. The top surface 12a of the cylinder block 12 is less likely to be hit by the stone chips and the like that are kicked up from the ground than the right surface 12b, the bottom surface 12c, and the left surface 12d. Therefore, the knock sensor 41 can be prevented from being hit by the stone chips and the like.

Note that in the present preferred embodiment, the intake pipe 35 or the throttle body 36 is disposed above the knock sensor 41, as illustrated in FIG. 3. The intake pipe 35 and the throttle body 36 are components that have greater strength than the knock sensor 41. Even if an object falls from above, the knock sensor 41 can be protected by the intake pipe 35 or the throttle body 36.

According to the present preferred embodiment, as illustrated in FIG. 2, the boss 40 is disposed at a position such that the extension line L2 of the center of the boss 40 passes through the cylinder 15, particularly at a position such that the extension line L2 intersects the cylinder axis L1. This means that the knock sensor 41 is disposed at a position such that knocking can be detected more easily. Therefore, the present preferred embodiment can increase the detection accuracy of the knock sensor 41.

## Second Preferred Embodiment

As illustrated in FIG. 3, in the engine 10 according to the first preferred embodiment, the boss 40 is preferably connected to some of the fins 30. However, it is not absolutely necessary that the boss 40 is connected to some of the fins 30. As illustrated in FIG. 5, in the engine 10 according to the second preferred embodiment, the boss 40 is independent from the fins 30.

In the present preferred embodiment, no fin 33 is provided at a base portion (in other words, a rear portion) 12r of the cylinder block 12. The boss 40 is provided at the base portion 12r of the top surface of the cylinder block 12, that is, at the portion in which no fin 33 is provided. However,

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the boss **40** may be provided on any other surface of the cylinder block **12** than the top surface thereof.

In the present preferred embodiment as well, the heat insulation member **45** is provided on the boss **40**, and the knock sensor **41** is provided further on the heat insulation member **45**. The heat insulation member **45** is disposed between the boss **40** and the knock sensor **41**. The heat insulation member **45** and the knock sensor **41** are mounted to the boss **40** by a bolt **42**. The structure and arrangement of the boss **40**, the heat insulation member **45**, the knock sensor **41**, and the bolt **42** are preferably the same as those in the first preferred embodiment (see FIG. 4).

As illustrated in FIG. 5, as the fan **28** rotates in association with rotation of the crankshaft **17**, the air outside the air shroud **30** is sucked through the suction port **31** into the air shroud **30**. The sucked air **A** is guided generally frontward, and is supplied to the boss **40** and the knock sensor **41**. The boss **40** and the knock sensor **41** are cooled by this air. The air that has cooled the boss **40** and the knock sensor **41** flows along the cylinder block **12** and the cylinder head **13** from the front to the left, to cool the cylinder block **12** and the cylinder head **13**.

As illustrated in FIG. 5, fins **33** are provided in front of the boss **40**. The air shroud **30** is configured so as to guide air successively to the boss **40** and then to the fins **33** in that order. The air with a relatively low temperature that is sucked from the suction port **31** flows through the surrounding region of the boss **40** and the knock sensor **41**. At that time, the air itself is heated because it cools the boss **40** and the knock sensor **41**, and the temperature thereof increases. The air the temperature of which has been raised is supplied to the fins **33**. The fins **33** are cooled by the air the temperature of which has been raised.

In the present preferred embodiment as well, the temperature increase of the knock sensor **41** can be suppressed and prevented because the heat insulation member **45** is provided between the boss **40** and the knock sensor **41**. Moreover, since vibration is transmitted from the boss **40** to the knock sensor **41** through the bolt **42**, the detection accuracy of the knock sensor **41** can be kept high, although the heat insulation member **45** is interposed between the boss **40** and the knock sensor **41**. In addition thereto, substantially the same advantageous effects as obtained by the first preferred embodiment can be obtained.

In addition, in the present preferred embodiment, the air shroud **30** is configured so as to guide air successively to the boss **40** and then to the fins **33** in that order. For this reason, the boss **40** and the knock sensor **41** are supplied with the air with a relatively low temperature before cooling the fins **33**. Thus, the temperature increase of the knock sensor **41** can be suppressed and prevented more effectively.

## Third Preferred Embodiment

In the first and second preferred embodiments, the boss **40** is provided on the cylinder block **12**. However, the boss **40** may be provided on a portion other than the cylinder block **12**. As illustrated in FIG. 6, in the engine **10** according to the third preferred embodiment, the boss **40** is provided on the crankcase **11**.

The position of the boss **40** is not particularly limited, but in the present preferred embodiment, the boss **40** is provided on a front portion of the crankcase **11**. In other words, the boss **40** is arranged on a portion of the crankcase **11** near the cylinder block **12**. The boss **40** is provided on the top surface **11a** of the crankcase **11**, and it is provided so as to extend frontward and obliquely upward.

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The rest of the configurations are similar to the second preferred embodiment, and therefore further description thereof will be omitted. In the present preferred embodiment as well, the air shroud **30** is fitted to the crankcase **11**, the cylinder block **12** and the cylinder head **13**.

The air that is sucked by the fan **28** from the suction port **31** generally flows over the crankcase **11**, then the cylinder block **12**, and then the cylinder head **13** in that order. The air before cooling the cylinder block **12** and the cylinder head **13** is supplied to the boss **40** and the knock sensor **41**. The air that has cooled the boss **40** and the knock sensor **41** is thereafter supplied to the cylinder block **12** and the cylinder head **13**, to cool the cylinder block **12** and the cylinder head **13**.

The crankcase **11** has a lower temperature than the cylinder block **12** and the cylinder head **13**. Therefore, according to the present preferred embodiment, the temperature increase of the boss **40** can be suppressed even more, and the temperature increase of the knock sensor **41** can be suppressed and prevented even further.

The air with a relatively low temperature that has not yet been heated by the cylinder block **12** or the cylinder head **13** is supplied to the boss **40** and the knock sensor **41**. As a result, the boss **40** and the knock sensor **41** can be cooled effectively.

## Fourth Preferred Embodiment

In the first and second preferred embodiments, the boss **40** is provided on the top surface **12a** of the cylinder block **12**. In the third preferred embodiment, the boss **40** is provided on the top surface **11a** of the crankcase **11**. However, the boss **40** may be provided on, for example, other surfaces of the cylinder block **12** than the top surface **12a** thereof. As illustrated in FIG. 7, in the engine **10** according to the fourth preferred embodiment, the boss **40** is provided on the right surface **12b** of the cylinder block **12**.

In the present preferred embodiment, no fin **33** is provided at a base portion of the cylinder block **12**, and the boss **40** is provided on the right surface **12b** of the base portion thereof. The boss **40** is independent from the fins **33**. However, the boss **40** may be connected to some of the fins **33** as in the first preferred embodiment. The rest of the configurations are similar to the first preferred embodiment, and therefore further description thereof will be omitted.

In the present preferred embodiment as well, the temperature increase of the knock sensor **41** can be suppressed and prevented because the heat insulation member **45** is provided between the boss **40** and the knock sensor **41**. Moreover, since vibration is transmitted from the boss **40** to the knock sensor **41** through the bolt **42**, the detection accuracy of the knock sensor **41** can be kept high, although the heat insulation member **45** is interposed between the boss **40** and the knock sensor **41**. In addition thereto, substantially the same advantageous effects as obtained by the first preferred embodiment can be obtained.

The suction port **31** is provided in a right side portion of the air shroud **30**, and the air is introduced from the right to the left. The boss **40** is provided on the right surface **12b** of the cylinder block **12** and the knock sensor **41** is disposed on the right side of the cylinder block **12**. Accordingly, the air introduced from the suction port **31** can be supplied immediately to the boss **40** and the knock sensor **41**. As a result, the boss **40** and the knock sensor **41** can be cooled effectively.

In this preferred embodiment as well, the boss **40** and the knock sensor **41** are supplied with the air with a relatively

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low temperature before cooling the fins 33. As a result, the boss 40 and the knock sensor 41 can be cooled effectively, and the temperature increase of the knock sensor 41 can be suppressed and prevented sufficiently.

## Fifth Preferred Embodiment

The engine 10 in the foregoing preferred embodiments is preferably a horizontally mounted type engine in which the cylinder axis L1 extends in a horizontal direction or in a substantially horizontal direction. However, the direction of the cylinder axis L1 is not limited to the horizontal direction or the substantially horizontal direction. As illustrated in FIG. 8, an engine 50 according to the fifth preferred embodiment is what is called a vertically mounted type engine, in which the cylinder axis L1 extends in a substantially vertical direction. The inclination angle of the cylinder axis L1 from a horizontal plane is about 45 degrees or greater.

The straddle-type vehicle according to the present preferred embodiment is what is called an on-road-type motorcycle 1A. The motorcycle 1A is equipped with a front wheel 3, a rear wheel 4, and a vehicle body 2 including a handlebar 6, a seat 7, and so forth. The rear wheel 4 is coupled to an engine 50 via a transmission chain (not shown) and is driven by the engine 50. In the present preferred embodiment, the engine 50 is fixed to the engine unit 9 but is non-swingably fixed to a body frame 9.

The engine 50 includes a crankcase 11, a cylinder block 12 extending frontward and obliquely upward from the crankcase 11, a cylinder head 13 connected to an upper portion of the cylinder block 12, and a cylinder head cover 14 connected to an upper portion of the cylinder head 13. In the present preferred embodiment as well, fins 33 are provided on the cylinder block 12 and the cylinder head 13. A boss (not shown) is provided on the rear surface of the cylinder block 12. A heat insulation member (not shown) is provided on the boss. A knock sensor 41 is provided on the heat insulation member. The heat insulation member and the knock sensor 41 are mounted to the boss by a bolt 42. The structure and arrangement of the boss, the heat insulation member, the knock sensor 41, and the bolt 42 are preferably the same as those in the first preferred embodiment (see FIG. 4), and therefore further description thereof will be omitted.

In the present preferred embodiment, as the motorcycle 1A runs, air flows from the front toward the rear of the engine 50. The cylinder block 12, the cylinder head 13, and so forth are cooled by the air flowing from the front. The boss and the knock sensor 41 are also cooled by the airflow produced in association with running of the motorcycle. Although not shown in the figure, it is also possible to provide an air guide member to guide to the boss the airflow that flows from the front to the rear.

In the present preferred embodiment as well, the temperature increase of the knock sensor 41 can be suppressed and prevented because the heat insulation member is provided between the boss and the knock sensor 41. Moreover, since vibration is transmitted from the boss to the knock sensor 41 through the bolt 42, the detection accuracy of the knock sensor 41 can be kept high, although the heat insulation member is interposed between the boss and the knock sensor 41. In addition thereto, substantially the same advantageous effects as obtained by the first preferred embodiment can be obtained.

## Other Modified Preferred Embodiments

In the foregoing preferred embodiments, the head 42a of the bolt 42 and the obverse surface 41a of the knock sensor

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41 are preferably in direct contact with each other (see FIG. 4). However, it is also possible to interpose another member, such as a washer, between the head 42a of the bolt 42 and the obverse surface 41a of the knock sensor 41. Various modifications are possible as long as the detection accuracy of the knock sensor 41 does not degrade significantly.

As illustrated in FIG. 2, in the engine 10 according to the first preferred embodiment, the boss 40 is preferably provided at a position such that the extension line L2 of the center of the boss 40 intersects the cylinder axis L1. However, the position of the boss 40 is not particularly limited. For example, it is also possible to allow the boss 40 to be arranged rightward or leftward from the cylinder axis L1.

In the foregoing preferred embodiments, the engines 10 and 50 are preferably air-cooled engines. However, the internal combustion engine according to the present invention may be an engine in which a portion thereof is cooled by coolant. For example, it is possible that a water jacket may be provided in the cylinder head, and the cylinder head may be cooled by coolant. The fin or fins may be provided only on the cylinder block.

In the foregoing preferred embodiments, the engines 10 and 50 are preferably four-stroke engines. However, the internal combustion engine according to the present invention may be a two-stroke engine.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A single-cylinder internal combustion engine for a vehicle, the single-cylinder internal combustion engine comprising:

- a crankcase accommodating a crankshaft;
- a cylinder block connected to the crankcase and including a cylinder provided therein;
- a cylinder head connected to the cylinder block;
- a sensor mounting boss provided on the crankcase, the cylinder block, or the cylinder head;
- a sensor arranged to detect knocking of the single-cylinder internal combustion engine, the sensor being mounted to the sensor mounting boss;
- a fin provided on at least a portion of the cylinder block and the cylinder head; and
- a heat insulation member interposed between the sensor mounting boss and the sensor; wherein
  - the heat insulation member is made of a material having a lower thermal conductivity than that of the sensor mounting boss;
  - the sensor is arranged to detect vibrations;
- the single-cylinder internal combustion engine further includes a bolt arranged to mount the sensor and the heat insulation member to the sensor mounting boss, a portion of the bolt being in contact with the sensor mounting boss and another portion of the bolt being in direct contact with the sensor;
- each of the cylinder block and the cylinder head includes a top surface, a bottom surface, a left surface, and a right surface;
- an intake pipe is connected to one of the top surface, the bottom surface, the left surface, and the right surface of the cylinder head, and an exhaust pipe is connected to an opposite surface to the surface to which the intake pipe is connected; and

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the sensor mounting boss is provided on the surface of the cylinder head to which the intake pipe is connected or on a surface of the cylinder block that corresponds to the surface of the cylinder head to which the intake pipe is connected.

2. The single-cylinder internal combustion engine according to claim 1, wherein:

the heat insulation member includes a through-hole provided therein;

the sensor includes an obverse surface, a reverse surface in contact with the heat insulation member, and a through-hole passing from the obverse surface to the reverse surface, and the sensor is arranged to detect vibrations; and

the single-cylinder internal combustion engine further comprises:

a bolt arranged to mount the sensor and the heat insulation member to the sensor mounting boss, the bolt including a shaft portion and a head, the shaft portion penetrating through the through-hole of the sensor and the through-hole of the heat insulation member and being inserted in the sensor mounting boss, and the head being in contact with the obverse surface of the sensor and having a larger diameter than that of the shaft portion.

3. The single-cylinder internal combustion engine according to claim 1, wherein the sensor mounting boss is provided on the cylinder block.

4. The single-cylinder internal combustion engine according to claim 1, wherein the sensor mounting boss is provided on the cylinder head.

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5. The single-cylinder internal combustion engine according to claim 1, wherein:

the sensor mounting boss is made of a metal; and the heat insulation member is made of a resin.

6. The single-cylinder internal combustion engine according to claim 1, wherein:

the sensor mounting boss is made of a metal; and the heat insulation member is made of a ceramic.

7. The single-cylinder internal combustion engine according to claim 1, wherein the sensor mounting boss is continuous with the fin.

8. The single-cylinder internal combustion engine according to claim 1, further comprising an air guide member mounted to at least a portion of the crankcase, the cylinder block, or the cylinder head and arranged to guide air at least to the sensor mounting boss.

9. The single-cylinder internal combustion engine according to claim 8, further comprising:

a fan disposed at a side of the crankcase and arranged to be driven by the crankshaft; wherein

the air guide member includes a shroud including a suction port provided at a position facing the fan.

10. The single-cylinder internal combustion engine according to claim 1, wherein the heat insulation member is a separate part from the sensor, the cylinder block, and the cylinder head.

11. A straddle-type vehicle comprising:

a single-cylinder internal combustion engine according to claim 1.

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